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(54) A LINING TUBE FOR AND METHOD OF LINING A PIPELINE

(71) We, A/S DEN NORSKE REMFABRIK, a Norwegian Company, of P.O. Box 1, N-1410 Kolbotn, Norway, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to a tube of reinforced elastomeric material for use as a lining for a pipeline of rigid material and to a method of lining such a pipeline to improve the water-tightness thereof.

The invention is applicable particularly, but not exclusively, to the lining of concrete pipes for the conveyance of sewage and for the drainage of water.

Many municipal pipeline networks consisting of concrete pipes and used for draining waste water and the like, badly need reconditioning. Due to their inelasticity, the concrete pipes, which are buried in trenches in the soil, are very exposed to external mechanical stresses in the event of settling and vibration of the ground. Such stresses will often give rise to crack formations and leakage in the pipes and/or to a loosening of jointing material in the joints between them.

Lately, the quality of the concrete pipes and the sealing at the joints have been improved, a fact which to some degree has reduced the leakage in newer pipeline networks. In the latest years also thermoplastic and thermosetting plastics materials have been used as a base material for drains and waste water pipelines, and this fact has resulted in a simpler sealing of the joints. However, plastics pipes are not capable of withstanding the same mechanical stresses as concrete pipes.

However, a loss or leakage of approximately 25% is not uncommon in municipal pipeline networks, and this is to a large degree due to the fact that the pipeline networks, which consist of concrete pipes, are old and defective. Attempts have been made to remedy this disadvantage by spraying onto the pipes an internal layer of cement mortar, but the result has usually been unsatisfactory since it has not been possible to control the application of mortar and the supply of water.

It has also been proposed to line a pipeline with a rigid plastics pipe. Plastics pipes, however, have limited wear characteristics, and it is difficult to insert a plastics pipe in a concrete pipe, partly because an open straight distance corresponding to the length of the plastics pipe must be available at the place of insertion, and partly because concrete pipes have an irregular inner surface, e.g. due to damage or fouling. The plastics lining cannot, therefore, have a larger diameter than the most narrow place in the concrete pipe, e.g. at the place of damage or the place of congestion. Such a lining method by means of rigid plastics pipes will in general lead to a reduction of the cross-section of the line by 50 to 60%, and the space between the pipes and the lining must usually be filled with, for example, mortar.

Swedish Patent Specification No. 343,357 and British Patent Specification No. 1,437,273, describe methods for sealing a pipeline by means of a flexible pipe or tube which prior to insertion in the pipeline, is deformed to a reduced cross-section which is considerably smaller than the cross-section of the pipe. According to Swedish Patent Specification No. 343,357, the deformation of the tube is accomplished by means of steel straps having releasable locking means. However, the steel straps increase the friction between the tube and the pipeline, thus increasing the required pulling force for pulling the tube into position in the pipeline and, in the area of the steel straps and the locking means, a space will be present between the inner wall of the pipe and the outer wall of the tube when the tube has been positioned and has regained its original shape in the pipeline. Besides, the locking means are difficult to release.

In British Patent Specification No. 1,437,273, the use of non-metallic straps has

been suggested for imparting a deformed cross-section to the tube, the cutting of said straps being accomplished by means of a cutting means adapted to run along a trough formed in the deformed tube. However, in order to make such a system operable, the tube must be accurately positioned in the pipeline, i.e. the opening of the trough must be facing upwards, otherwise, the cutting means running therein will leave the trough and fail to accomplish its function. Such a system will, therefore, not be useful for the lining of long pipelines as it is difficult to prevent the lining tube from becoming twisted, which may cause a malfunction of the cutting means.

Also, such tubes suffer from the disadvantage of not being armoured or reinforced, so that they are not stiff enough to withstand compression due to external water pressure.

According to the present invention, there is provided a tube of reinforced elastomeric material for lining a pipeline of rigid material, wherein said tube is composed of an elastomeric material reinforced by substantially circumferentially extending elastic threads or filaments embedded therein; is resiliently deformable into a folded condition, with fold lines extending longitudinally thereof, so that its overall dimensions in all directions at right angles to its length are reduced and is adapted, when relieved of constraint while in its folded condition, to expand resiliently to its original undeformed condition.

The watertightness of a leaking pipeline can be greatly improved by lining it with a tube according to the invention. Moreover, because of its substantial resistance to compression, such a lining tube will not be liable to collapse under the action of external water pressure, e.g. when it is used in a non-waterproof pipeline and water at a pressure substantially greater than that within the lining tube penetrates through this pipeline from the outside.

The tube according to the invention, because of its flexibility, can easily be inserted in a pipeline without any risk of its becoming damaged. Also, when so inserted, it completely fills the pipeline, so that the reduction in the flow area of the latter, due to its presence, is relatively small. In addition, since it is composed mainly of rubber, it has excellent resistance to wear and to attack by acid and basic chemicals.

The invention also provides a method of lining a pipeline of rigid material to improve the watertightness thereof, comprising the steps of producing a tube of elastomeric material reinforced by elastic threads or filaments embedded therein and extending substantially circumferentially with respect thereto, said tube having, in its undeformed condition, an outer diameter corresponding to the inner diameter of the pipeline and being sufficiently flexible to enable it to be deformed into a folded condition, with fold lines extending longitudinally thereof, such that its overall cross-sectional dimensions are reduced to less than the inner diameter of the pipeline, without being thereby permanently deformed, and said tube, in its undeformed condition, having resistance to compression under the action of external fluid pressure; deforming said tube into said folded condition, pulling said tube through said pipeline, while maintaining said tube in the said folded condition, to a position in which said tube extends through the entire length of said pipeline; and then allowing said tube to re-expand resiliently to its undeformed condition in which it forms within said pipeline a tubular lining, all parts of the outer surface of which are in contact with or in close proximity to corresponding inner surface parts of the pipeline.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a section of part of a pipeline system including a pipeline provided with a tubular lining,

Figure 2 shows the detail A in Figure 1 on a larger scale,

Figure 3 is a cross-section taken along the line B B in Figure 1 on a larger scale, and

Figure 4 is an end view of the pipeline in which the tubular lining is shown deformed.

In Figure 1 there is shown a section of a pipeline system consisting of a manhole 1 having a pipeline connected thereto, the pipeline generally being designated 2 and consisting of several concrete pipe sections of which two are shown and designated 2*a* and 2*b*, respectively. Within the pipeline 2 there is provided a tube 3 of rubber which serves as a water-proof lining of the pipeline 2.

As illustrated in Figures 2 and 3, the rubber tube 3 is reinforced with threads 4 of a synthetic material. The threads 4 are embedded in the rubber material and extend around the circumference of the tube, i.e. at approximately 90° to the longitudinal direction of the tube and pipe. The outer diameter of the tube 3 substantially corresponds to the inner diameter of each pipe section 2*a*, 2*b*, so that the outer surface of the tube 3 when the latter is positioned in the pipeline 2, will be in surface-to-surface contact with substantially the entire inner surface area of each pipe section 2*a*, 2*b* of the pipeline.

Prior to insertion thereof in the pipeline 2, the tube 3 is deformed or folded for example to a cross-sectional shape as illustrated in Figure 4 and strapped by an external strap 5, so that it can be pulled into and positioned in the pipeline 2. To facilitate the deformation of the tube 3, it is subjected to vacuum prior to being strapped. After the tube 3 has reached its correct position in the pipeline 2, the strap 5 is released and the vacuum relieved, so that the tube 3 is caused by its own elasticity to reassume its original shape and is pressed against the inner wall surface of the pipeline 2. If

necessary, the tube 3 may be subjected to an internal over-pressure to aid in restoring it to its original shape. If irregularities present in the pipeline are so large that the inherent stiffness of the reinforced tube 3 is not sufficient for this purpose, an internal over-pressure may be imparted to the tube until it has regained its original circular shape. Such an over-pressure may also be used to rupture the straps 5. Instead of separate straps, a continuous hose or sheath of thin plastics material may be used.

The method according to the invention provides a rapid and efficient lining of pipes in waterline networks and the fact that the tube, as distinct from its reinforcement is composed of rubber, ensures that it has very favourable properties in regard to resistance to wear as well as to acid and basic influences are also achieved.

The synthetic threads which are used are preferably of the type "ICI Terylene Macrofil". The coarse filaments of the Macrofil yarn provide a high compression resistance along the axis of the yarn, and rubber compositions reinforced with Macrofil yarn may be rendered very stiff. In order to facilitate the deformation of the reinforced tube before it is pulled into position in the tube, it may be preferable to position the reinforcement in a single layer which preferably extends along the neutral axis. However, in practice, it will be an advantage to position a single reinforcing layer somewhat outside the neutral axis, as a thicker wear layer of rubber is thereby achieved.

A second favourable reinforcing method consists in using two reinforcing layers, each of which is located as far from the neutral axis as is practically possible. A tube so reinforced will have a very high bending stiffness even when not being supported against the internal surface of the concrete pipeline, which is an advantage in cases where the concrete pipeline becomes damaged. Preferably, the Macrofil threads are woven into mats which may be embedded circumferentially in the rubber tube. The threads may alternatively be woven into strips which extend helically around the axis of the tube.

If a lining tube having a wall thickness of 8 mm is used for a water pipeline having a diameter of 300 mm, the original inner cross-sectional area of the pipeline will be reduced by approximately 12% subsequent to being lined. This is a considerable improvement compared with the lining method based on the insertion of rigid plastics pipes, in which the cross-sectional area of the pipeline is reduced by 50 to 60%.

The invention offers advantages not only as regards reduced laying time, especially since lengths of reinforced rubber tube may be joined end-to-end to provide a tube of a suitable total length which is wound on a drum. During the winding, the tube is folded together and is maintained in the folded condition by means of straps or cords. Then the tube is subjected to a vacuum. The wound tube length can then be pulled into position in a pipeline through an existing manhole, whereupon the straps are removed and the vacuum pressure relieved, so that the tube returns to its original shape.

WHAT WE CLAIM IS:-

1. A tube of reinforced elastomeric material for lining a pipeline of rigid material, wherein said tube is composed of an elastomeric material reinforced by substantially circumferentially extending elastic threads or filaments embedded therein; is resiliently deformable into a folded condition, with fold lines extending longitudinally thereof, so that its overall dimensions in all directions at right angles to its length are reduced and is adapted, when relieved of constraint while in its folded condition, to expand resiliently to its original undeformed condition.

2. A tube according to Claim 1, wherein the elastic threads or filaments are woven together into mats which are embedded in the elastomeric material of the tube and extend circumferentially of the same.

3. A tube according to Claim 1, wherein the elastic threads or filaments extend helically around the longitudinal axis of the tube.

4. A tube according to any of the preceding claims, wherein the elastic threads or filaments or the mats formed thereof are positioned in a single layer in the neutral axis of the tube.

5. A tube according to any of Claims 1 to 4, wherein the elastic threads or filaments or the mats formed thereof are positioned in two or more layers each of which is located radially inside or radially outside the neutral axis of the tube.

6. A tube according to any of the preceding claims, wherein the threads or filaments are composed of a synthetic material.

7. A tube according to Claim 6, wherein the threads or filaments are made of a polyester material.

8. A method of lining a pipeline of rigid material to improve the watertightness thereof, comprising the steps of producing a tube of elastomeric material reinforced by elastic threads or filaments embedded therein and extending substantially circumferentially with respect thereto, said tube having, in its undeformed condition, an outer diameter corresponding to the inner diameter of the pipeline and being sufficiently flexible to enable it to be deformed into a folded condition, with fold lines extending longitudinally thereof, such that its overall cross-sectional dimensions are reduced to less than the inner diameter of the pipeline, without being thereby permanently deformed, and said tube, in its undeformed condition, having resistance to compression under the action of external fluid pressure; deforming said tube into said folded condition, pulling said tube through said pipeline, while maintaining said tube in the said folded condition, to a position in which said

tube extends through the entire length of said pipeline; and then allowing said tube to re-expand resiliently to its undeformed condition in which it forms within said pipeline a tubular lining, all parts of the outer surface of which are in contact with or in close proximity to corresponding inner surface parts of the pipeline.

9. A method according to Claim 8, wherein the tube is maintained in its folded condition, which being pulled through the pipeline, by means of a previously applied external strap which is removed when the tube has reached the said position in which it extends through the entire length of the pipeline to allow the tube to re-expand resiliently.

10. A method according to Claim 9, wherein the deformation of the tube into its folded condition is assisted by subjecting the interior of the tube to vacuum prior to the application of the external strap, the vacuum being relieved when the tube has reached said position in which it extends through the entire length of the pipeline.

11. A method according to Claim 9, wherein the resilient re-expansion of the tube to its undeformed condition is assisted by the application of fluid under pressure to the interior of the tube after the said vacuum has been relieved.

12. A pipeline provided with a reinforced lining of elastomeric material, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

13. A method of lining a pipeline of rigid material to improve the watertightness thereof, substantially as described with reference to and as illustrated in the accompanying drawings.

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1553408 COMPLETE SPECIFICATION

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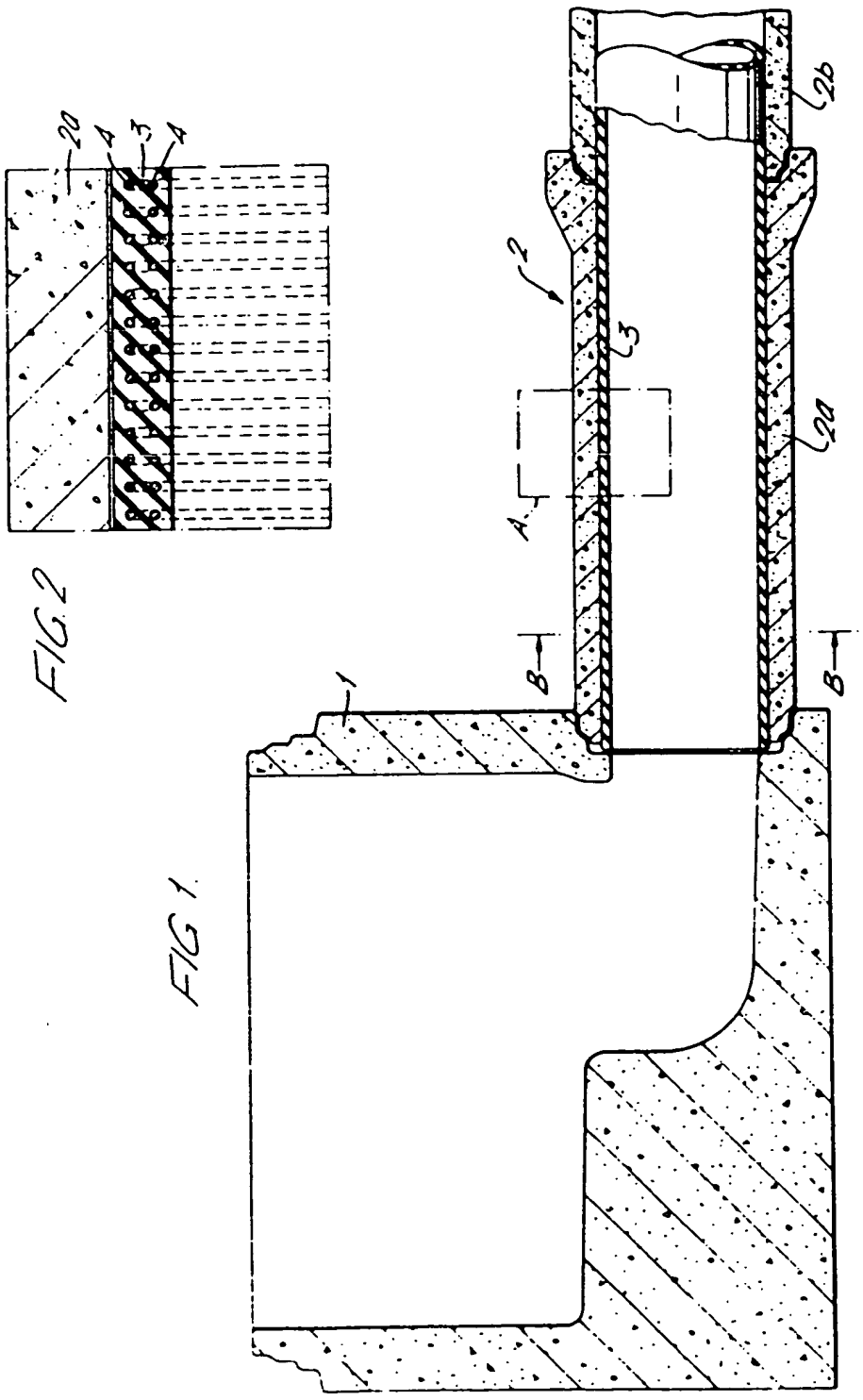

FIG 2

FIG 1

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Sheet 2

FIG.3

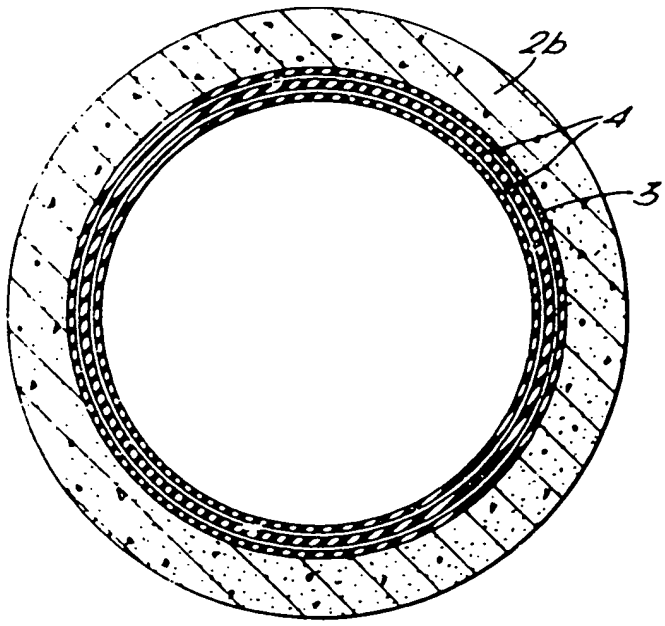

FIG.4